Convective-scale Warn-on-Forecast:
The Severe Weather Forecast Improvements Project

Report on Project Activities

March 2010 through September 2010

Personnel

The first six months of funding for the Warn-on-Forecast (WoF) project has led to progress in a number of important areas. The most important project success to date is in the recruitment of talented personnel. These scientists bring needed expertise to the project and will help us build stronger connections between the project partners. The new personnel and their home institutions are:

Dr. Jidong Gao	National Severe Storms Laboratory (NSSL)
Dr. David Dowell	Global Systems Division (GSD)
Dr. Thomas Jones	NSSL
Dr. James Correia	Storm Prediction Center (SPC)
Mr. Gabe Garfield	Norman National Weather Service Forecast Office (WFO)
Dr. Corey Potvin	NSSL

In addition, the project is supporting several graduate students whose research will help advance WoF project goals. These students are:

Ms. Stephanie Hoekstra	Social Sciences Woven Into Meteorology (SSWIM), University of Oklahoma (OU)
Ms. Rebecca Belobraydich	School of Meteorology, OU
Mr. Ryan Sobash	School of Meteorology, OU

We are delighted to have such talented people added to the project.

Deliverables Completed

Several first year deliverables have already been completed. The field phase of the Verification of the Origin of Rotation in Tornadoes Experiment 2 (VORTEX2) ended in June 2010. Unique observational data were collected on 30 supercell thunderstorms and 10 tornadoes were sampled (1 or 2 were EF2 tornadoes). There were also several cases of upscale growth that were observed. These data sets will provide excellent verification data for WoF data assimilation experiments and hopefully lead to an improved understanding of tornadogenesis. Model-to-observation statistics using surface mesonet observations provided by MADIS are now being computed and a weekly use list for winds automatically produced. The model data being used for this purpose are 1-h 13-km Rapid Update Cycle (RUC) model forecasts. The use list consists of all mesonet stations where the last seven days of model-to-observation statistics indicates a vector difference between the observed wind and the model wind is less than 1.0 m s^{-1}. Finally, the WoF project also has a webpage that outlines the project goals and project plans and lists all the partner institutions (http://www.nssl.noaa.gov/projects/wof).

Progress on Tasks

Data Quality Control. Initial work to develop quality controlled radar data sets for use in data assimilation and automated quality control studies focused on determining the most efficient techniques for the manual editing of WSR-88D data sets. Two student research associates were hired and trained in the data editing techniques, with oversight provided by NSSL scientists. The first case to undergo quality control was the 5 June 2009 data from Cheyenne, WY, for which VORTEX2 collected an extensive data set. In addition, several radar data quality control methods employing velocity and reflectivity data as well as dual-polarization parameters have been identified for testing and comparison.

Data Assimilation. Good progress is also being made in various data assimilation applications and experiments. New Digital Filter Initialization (DFI) experiments are under preparation for testing in the High-Resolution Rapid Refresh (HRRR) model at GSD. Variations in the latent heat (related to cloud-life-time parameter) at 13km in the parent RUC/Rapid Refresh (RR) model have been performed, and a new test period is currently being prepared from summer 2010. Resolution experiments also have been performed for HRRR on two convective system cases with a single 3 km domain and a 3 km domain with a 1 km nest added. Results at 1 km show some improved gust-front leading edge and cold pool characteristics, but additional needed improvement appears to be related to pre-convective environmental factors (mid-level moisture) and cloud microphysics schemes.

A preliminary version of a hybrid 3D variational (3DVAR)-ensemble Kalman filter (EnKF) data assimilation system with dual-resolution capability has been developed at the Center for Analysis and Prediction of Storms (CAPS) based on existing 3DVAR and EnKF programs using the Advanced Regional Prediction System (ARPS) model grid. In the hybrid method, the relative weights assigned to the static and flow-dependent error covariances can be tuned, and the tuning can be case and scale dependent. The method is applied to the assimilation of simulated radar data for a supercell storm. Sensitivity experiments are performed with different amount of radar data and different combinations of the covariance weights. Results obtained using pure-3DVAR (with static covariance entirely), mixed covariance (within the variable framework), and the pure standard EnKF are compared. When data from a single radar are used, the pure EnKF method provides the best results for model dynamic variables, while the hybrid method provides the best results for hydrometeor related variables in term of RMS errors. Though the storm structures can be established reasonably well using the pure 3DVAR method, the RMS errors are generally worse than other two methods. When data from two radars are used, the RMS errors for hybrid method are the smallest for most of the model variables. With two radars, the results from the pure 3DVAR are closer to that of the pure EnKF method. The use of dual-resolution has the advantage of reducing computational cost of a standard single-resolution hybrid 3DVAR-EnKF scheme, but the quality of analysis is worse than all other methods. For this idealized case, more

weights for flow-dependent error covariances generally have better results. Tests also indicate that the hybrid scheme can reduce the storm spin-up time.

Results showing the value of using variations in microphysical parameters to EnKF radar data assimilation for deep convection are being finalized at NSSL and should be submitted for publication later this year. Applications of the Weather Research and Forecasting (WRF) model using the Data Assimilation Research Testbed (DART) EnKF system to provide improved environmental forecasts for severe weather events and to study the 8 May 2003 tornadic supercell thunderstorm over Oklahoma City are moving forward. A realtime 3DVAR analysis at 1 km grid spacing was provided by CAPS to the Hazardous Weather Testbed (HWT) during the spring 2010 season to explore the value of these analyses to the warning process. Up to four separate 200x200 km domains were run each afternoon and early evening with new analyses created every 5 minutes. Three of the domains were controlled by an automated process that searches for severe storm locations, while the fourth domain was manually controlled by a meteorologist through a Google Maps interface. The raw variables produced by the 3DVAR analysis include moisture, temperature, and wind data. The initial application of this 3DVAR system yielded 10 high quality data sets of high-end supercell and/or tornado events, and several other weak events. These data are currently being analyzed, and preliminary results will be presented at the Severe Local Storms conference in October 2010.

Social Science Research. An initial meeting to discuss social science research plans was held in September 2010 and involved the majority of the WoF partners. Discussions focused upon ongoing activities of the organizations, new WoF social science research plans, expanding collaborations, and making sure that efforts were not being duplicated. One new research project will address the question of how public schools (K-12) respond to severe storm warnings and how increases in lead-time would influence their decision process. Monthly meetings are planned to develop a social science research plan by the end of the year.

Capabilities. Other program progress includes an ongoing assessment of the capabilities of the Weather Event Simulator (WES) to provide displaced realtime testing for WoF by GSD, new computer purchases to support program activities at the WFO and NSSL, and planning for spring 2011 HWT activities.

Summary

The progress made during the first six months of the WoF project is impressive, especially given that many new personnel had to be hired into key project areas. It appears that progress toward the first year deliverables is very good and continued good progress is expected during the remainder of this first year. Thanks to all of the WoF partner institutions for working together and developing the needed collaborations to strengthen the project and build healthy relationships among all the various groups.